

CLAIMS

1. A power output apparatus that outputs power to a drive shaft, said power output apparatus comprising:

5 an internal combustion engine;

 an electric power-mechanical power input-output unit that is linked with an output shaft of said internal combustion engine and with said drive shaft, and maintains or changes a driving state of said internal combustion engine and outputs
10 at least part of power from said internal combustion engine to said drive shaft through inputs and outputs of electric power and mechanical power;

 a motor that is capable of inputting and outputting power from and to said drive shaft;

15 an accumulator that is capable of supplying and receiving electric power to and from said electric power-mechanical power input-output unit and said motor; and

 a controller comprising: an input-output restriction setting module that sets an input restriction and an output restriction of said accumulator; a drivable range setting module that sets a drivable range of said electric power-mechanical power input-output unit based on the settings of input and output restrictions; a power demand setting module that sets a power demand required for said drive shaft in
20 response to an operator's manipulation; and a driving control module that controls said internal combustion engine, said
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electric power-mechanical power input-output unit, and said motor to drive said electric power-mechanical power input-output unit in the setting of drivable range and to output a power corresponding to the setting of power demand to said 5 drive shaft.

2. A power output apparatus in accordance with claim 1, wherein said drivable range setting module sets the drivable range, based on the settings of input and output restrictions, a motor electric power demand to be input to and output from 10 said motor, an auxiliary machinery electric power to be supplied from said accumulator to auxiliary machinery, and a driving state of said electric power-mechanical power input-output unit.

3. A power output apparatus in accordance with claim 2, 15 wherein said drivable range setting module sets an allowable driving range of said internal combustion engine defined by said electric power-mechanical power input-output unit to the drivable range.

4. A power output apparatus in accordance with claim 3, 20 wherein said drivable range setting module specifies an allowable input-output electric power range input to and output from said electric power-mechanical power input-output unit based on the settings of input and output restrictions, the motor electric power demand, and the auxiliary machinery 25 electric power, calculates an allowable torque range output from said electric power-mechanical power input-output unit

according to the specified allowable input-output electric power range and the driving state of said electric power-mechanical power input-output unit, and sets the driving range of said internal combustion engine based on the
5 calculated allowable torque range.

5. A power output apparatus in accordance with claim 3, wherein said drivable range setting module sets a revolution speed range of said output shaft of said internal combustion engine to the drivable range.

10 6. A power output apparatus in accordance with claim 1, wherein said controller further comprises a target driving state setting module that sets a target driving state of said internal combustion engine based on the setting of power demand, and

15 said driving control module corrects the setting of target driving state according to the drivable range and controls said internal combustion engine, said electric power-mechanical power input-output unit, and said motor to drive said internal combustion engine in the corrected target
20 driving state.

7. A power output apparatus in accordance with claim 6, wherein said target driving state setting module sets at least a target revolution speed of said internal combustion engine as the target driving state, and

25 said driving control module corrects the setting of target revolution speed according to the drivable range and

controls said internal combustion engine, said electric power-mechanical power input-output unit, and said motor to drive said internal combustion engine at the corrected target revolution speed.

5 8. A power output apparatus in accordance with claim 1, wherein said driving control module controls said internal combustion engine, said electric power-mechanical power input-output unit, and said motor to output the power corresponding to the power demand within a range of the settings
10 of input and output restrictions to said drive shaft.

9. A power output apparatus in accordance with any one of claims 1 through 8, wherein said electric power-mechanical power input-output unit comprises:

15 a three-shaft power input-output assembly that is connected with three shafts, that is, said output shaft of said internal combustion engine, said drive shaft, and a third shaft, and specifies input and output of power from and to one residual shaft among said three shafts, based on powers input and output from and to two shafts among said three shafts; and
20 a generator that inputs and outputs power from and to said third shaft.

25 10. A power output apparatus in accordance with any one of claims 1 through 8, wherein said electric power-mechanical power input-output unit comprises a pair-rotor generator having a first rotor, which is linked with the output shaft of said internal combustion engine, and a second rotor, which

is linked with said drive shaft and rotates relative to the first rotor, said pair-rotor generator outputting at least part of the power from said internal combustion engine to said drive shaft through input and output of electric power by 5 electromagnetic interaction between the first rotor and the second rotor.

11. An automobile with an internal combustion engine mounted thereon,

said automobile comprising:

10 an electric power-mechanical power input-output unit that is linked with an output shaft of said internal combustion engine and with a drive shaft mechanically connected to an axle, and maintains or changes a driving state of said internal combustion engine and outputs at least part of power from said 15 internal combustion engine to said drive shaft through inputs and outputs of electric power and mechanical power;

a motor that is capable of inputting and outputting power from and to said drive shaft;

20 an accumulator that is capable of supplying and receiving electric power to and from said electric power-mechanical power input-output unit and said motor; and

a controller comprising: an input-output restriction setting module that sets an input restriction and an output restriction of said accumulator; a drivable range setting 25 module that sets a drivable range of said electric power-mechanical power input-output unit based on the settings

of input and output restrictions; a power demand setting module that sets a power demand required for said drive shaft in response to an operator's manipulation; and a driving control module that controls said internal combustion engine, said 5 electric power-mechanical power input-output unit, and said motor to drive said electric power-mechanical power input-output unit in the setting of drivable range and to output a power corresponding to the setting of power demand to said drive shaft.

10 12. An automobile in accordance with claim 11, wherein said drivable range setting module sets the drivable range, based on the settings of input and output restrictions, a motor electric power demand to be input to and output from said motor, an auxiliary machinery electric power to be supplied from said 15 accumulator to auxiliary machinery, and a driving state of said electric power-mechanical power input-output unit.

13. An automobile in accordance with claim 12, wherein said drivable range setting module sets an allowable driving range of said internal combustion engine defined by said 20 electric power-mechanical power input-output unit to the drivable range.

14. An automobile in accordance with claim 13, wherein said drivable range setting module specifies an allowable input-output electric power range input to and output from said 25 electric power-mechanical power input-output unit based on the settings of input and output restrictions, the motor electric

power demand, and the auxiliary machinery electric power, calculates an allowable torque range output from said electric power-mechanical power input-output unit according to the specified allowable input-output electric power range and the 5 driving state of said electric power-mechanical power input-output unit, and sets the driving range of said internal combustion engine based on the calculated allowable torque range.

15. An automobile in accordance with claim 13, wherein
10 said drivable range setting module sets a revolution speed range of said output shaft of said internal combustion engine to the drivable range.

16. An automobile in accordance with claim 11, wherein
said controller further comprises a target driving state
15 setting module that sets a target driving state of said internal combustion engine based on the setting of power demand, and
said driving control module corrects the setting of target driving state according to the drivable range and
controls said internal combustion engine, said electric
20 power-mechanical power input-output unit, and said motor to
drive said internal combustion engine in the corrected target
driving state.

17. An automobile in accordance with claim 6, wherein
said target driving state setting module sets at least a target
25 revolution speed of said internal combustion engine as the
target driving state, and

said driving control module corrects the setting of target revolution speed according to the drivable range and controls said internal combustion engine, said electric power-mechanical power input-output unit, and said motor to
5 drive said internal combustion engine at the corrected target revolution speed.

18. A control method of controlling a power output apparatus, said power output apparatus comprising: an internal combustion engine; an electric power-mechanical power
10 input-output unit that is linked with an output shaft of said internal combustion engine and with a drive shaft, and maintains or changes a driving state of said internal combustion engine and outputs at least part of power from said internal combustion engine to said drive shaft through inputs
15 and outputs of electric power and mechanical power; a motor that is capable of inputting and outputting power from and to said drive shaft; and an accumulator that is capable of supplying and receiving electric power to and from said electric power-mechanical power input-output unit and said
20 motor,

said control method comprising the steps of:

- (a) setting an input restriction and an output restriction of said accumulator;
- (b) setting a drivable range of said electric
25 power-mechanical power input-output unit, based on the settings of input and output restrictions, a motor electric

power demand to be input to and output from said motor, an auxiliary machinery electric power to be supplied from said accumulator to auxiliary machinery, and a driving state of said electric power-mechanical power input-output unit;

5 (c) setting a power demand required for said drive shaft in response to an operator's manipulation; and

(d) controlling said internal combustion engine, said electric power-mechanical power input-output unit, and said motor to drive said electric power-mechanical power
10 input-output unit in the setting of drivable range and to output a power corresponding to the setting of power demand to said drive shaft.

19. A control method in accordance with claim 18, said control method further comprising the step of setting a target
15 driving state of said internal combustion engine based on the setting of power demand, prior to said step (d),

wherein said step (d) corrects the setting of target driving state according to the drivable range and controls said internal combustion engine, said electric power-mechanical
20 power input-output unit, and said motor to drive said internal combustion engine in the corrected target driving state.